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APRIL-JUNE 1973

Robert R. Blandford

Teledyne Geotech

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| 13 ABSTRACT<br><p>This report summarizes the work done by the SDL during the period April through June 1973, and primarily concerns the seismic research activities related to the detection and identification of nuclear explosions and earthquakes. The report also contains brief discussions of the support tasks and data services which were performed for other government contractors and for participants in the VELA-UNIFORM and PRIME ARGUS projects.</p> <p>Reproduced by<br/>NATIONAL TECHNICAL<br/>INFORMATION SERVICE<br/>U S Department of Commerce<br/>Springfield VA 22151</p> |   |   |
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SEISMIC DATA LABORATORY  
QUARTERLY TECHNICAL SUMMARY REPORT  
April - June 1973

|                           |                                       |
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| AFTAC Project No.:        | VELA T/2706                           |
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| Contract No.:             | F33657-72-C-0009                      |
| Date of Contract:         | 01 July 1971                          |
| Amount of Contract:       | \$2,482,460                           |
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P.O. Box 334, Alexandria, Virginia 22313

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## ABSTRACT

This report summarizes the work done by the SDL during the period April through June 1973, and primarily concerns the seismic research activities related to the detection and identification of nuclear explosions and earthquakes. The report also contains brief discussions of the support tasks and data services which were performed for other government contractors and for participants in the VELA-UNIFORM and PRIME ARGUS projects.

I. INTRODUCTION

This quarterly report summarizes the technical work, support effort, and data services completed during the period April through June 1973.

Reviews of technical reports completed during the reporting period are contained in Section II under descriptive headings. Section III is a summary of the support and service tasks performed for other government contractors for VELA-UNIFORM and PRIME ARGUS participants.

The engineering study of seismic arrays, SDL Report 304, has been distributed in accordance with instructions from VSC.

II. WORK COMPLETED

A.  $M_s - m_b$  Characteristics of Earthquakes in the Eastern Himalayan Region - No. 296

The results of a study of  $M_s$  vs  $m_b$  characteristics of earthquakes in the Eastern Himalayan region are given in this report. It is shown that in this region some earthquakes occur which have  $M_s$  vs  $m_b$  characteristics similar to explosions, exhibiting low surface wave magnitudes relative to body wave magnitudes, when seen at the reporting stations available to this study. The application of station corrections does not change the general distribution and spread of points in the  $M_s$  vs  $m_b$  plane, and therefore it is unlikely that station (or path) effects

are the source of the anomalies. Focal depths of most of the events studied are shallow or normal and can also be ruled out as causes of low surface wave magnitudes. The geographical distribution of anomalous events correlates with various prominent geological features and probably reflects the distribution of tectonic stress in the area studied. The existence of these anomalous events in certain areas of the world decreases the effectiveness of the  $M_s$  vs  $m_b$  criterion in discriminating between earthquakes and explosions. Detection of the Rayleigh wave from these events is so difficult that further understanding of their mechanism is dependent on an improved monitoring capability with good azimuthal coverage.

B. P and PKP Coda Decay Characteristics  
for Earthquakes - No. 301

P and PKP coda characteristics are determined for earthquakes from 15 seismic regions as recorded at 17 World Wide Standard Seismograph Stations (WWSSS). In determining the coda characteristics for an event, amplitude measurements scaled relative to the largest excursion in the coda, are made in successive time windows, and the coda envelope obtained by connecting successive observations. The individual coda, average coda, and standard deviations about the average coda as a function of time into the coda (in units of  $m_b$ ) are given for each set of

measurements. The coda for events in a given region recorded at a given distance are found to be very similar to the coda for events from another region recorded at the same distance. That is, coda characteristics are determined primarily by the arrival times and amplitude of significant secondary phases. Further, the coda characteristics determined for large events ( $6.0 \lesssim m_b \lesssim 7.0$ ) appear applicable to smaller events ( $5.0 \lesssim m_b \lesssim 6.0$ ) as well. Using data in the range  $45^\circ < \Delta < 80^\circ$ , the long-term P-coda decay constant  $\lambda$  for elapsed times greater than four minutes is .0017 per second ( $e^{-\lambda t}$ ). In the range  $80^\circ < \Delta < 105^\circ$ , the decay constant is somewhat larger, being on the order of .0037 per second.

C. Long Period Rayleigh Waves from  
Earthquakes and Explosions - No. 307

Comparisons are made of Rayleigh wave spectra for NTS explosions and Nevada earthquakes and for a limited number of teleseismic explosions and earthquakes recorded in North America. For a given combination of source and receiver location, the explosions consistently exhibit the same spectral shape over a significant range of magnitudes while spectral shapes for earthquakes commonly vary in a manner that appears independent of magnitude, with some earthquake shapes closely matching those of explosions. The spectral shapes for explosions were commonly observed to vary significantly from station to station at

comparable distance ranges, probably because of path and receiver site effects. We conclude that neither Rayleigh spectral shape nor symmetry of raw surface wave radiation patterns is likely to be a reliable discriminant in general.

### III. SUPPORT AND SERVICE TASKS

In addition to the research studies discussed above the SDL completed the following support and service tasks:

#### A. Data Cataloging, Classifying and Retrieval

The library consists of seismograph data from the LRSM sites, the observatories LASA, TFO, UBO, WMO, BMO, CPO and additional data from other sources. The corresponding operational logs are also included in the library.

At the end of June 1973, the library contained approximately:

|        |                        |
|--------|------------------------|
| 35,107 | analog magnetic tapes  |
| 21,140 | digitized seismograms  |
| 5,666  | digital magnetic tapes |

Fifty-four digital tapes have been assigned to the HDT Project. The library also contained seismographic data on 16 mm and 35 mm film. Those are commonly from simultaneous recording of tape and film data at the observatories and the LRSM sites.

The following categories of digital tapes are in the library:

|       |   |
|-------|---|
| 281   | UBO multiplexed                         |
| 1,199 | LASA multiplexed                        |
| 918   | TFO long period (DGRADAS tapes)         |
| 624   | TFO short period (ASDAS tapes)          |
| 2,055 | Library tapes (A/D and D/D conversions) |
| 826   | Permanent save tapes                    |
| 1,636 | Operations tapes (scratch, save, etc.)  |

The analog tape library contains:

|        |   |
|--------|---|
| 9,305  | Compressed tapes                                |
| 332    | Composites                                      |
| 17,554 | Tapes saved as recorded (not compressed)        |
| 8,099  | Tapes scheduled for compression as time permits |

#### B. Equipment Modification

An error in design logic was uncovered in the VT-15 display processor. The hardware was wired as designed but apparently not designed to be used as specified in the VT-15 Graphics reference manual (DEC-15-GWSB-D). DEC was informed of this discrepancy and has since rewired the display processor to allow the user to enable and disable the light pen activity as specified in the above referenced manual.

#### C. Maintain and Operate Equipment

Because of a delay in the delivery of the

BUCODE 9-track, 1600 BPI tape drives, the equipment reconfiguration discussed in the Monthly Progress Report for May 1973 was rescheduled for 16 and 17 July.

Delivery of the BUCODE tape drives has been now rescheduled for 16 July.

A bad module was uncovered and replaced in the floating point processor. This module caused a malfunction in the set "A SIGN" positive micro coded instruction. This problem was not indicated during the running of the DEC supplied floating point hardware diagnostic routines.

#### D. Digital Programming

As a result of the problem discussed in "B" above progress on the SWAP01 software system was delayed approximately 8 days. A further delay of approximately 3 days was encountered because of the second problem mentioned in "C" above. This problem caused the following library routines to malfunction: DABS (double precision absolute value), SIGN (transfer of sign), JSIGN (double integer transfer of sign), DSIGN (double precision transfer of sign), DSIN (double precision sine), DCOS (double precision cosine). Approximately 95% of the coding effort on the DPMN Phase of SWAP01 is completed and this phase is now in the final debug stage. This phase should be completed by 18 July. As a result of re-evaluation of

hardware, software, design and coding problems we now estimate the visibility date of the SWAP01 software system to be late August 1973.

The Calcomp plotting package has been fully evaluated and debugged and is now ready for operation. There still exists a problem in reading tapes generated on the 360/44 tape drives. The PDP-15 drives are apparently detecting parity errors on each read of the tape. This problem will be resolved as soon as possible.

Varian did not meet the 10 June delivery date for the Varian printer plotter Data Plot II software. At this time we have requested another projected delivery date.

The bid from DEC on the RSX compatible Varian handler has been received. We are now trying to determine if and when we want to purchase the above software. This decision will be based in part on decisions made concerning the Varian hardware.

#### E. VELA and PRIME ARGUS DATA Copies

During the past year SDL supplied data or computer services to the following:

ACDA, Department of State, Washington D. C.  
Air Force Cambridge Research Laboratory  
Air Force Office of Scientific Research  
Commonwealth of Australia, Dept. of Natl. Development  
Dept. of Energy, Mines, and Resources, Ottawa, Canada  
General Atronics Corporation  
IBM

Institute of Geological Sciences, Great Britain  
 Lawrence Livermore Laboratories  
 Los Alamos Scientific Laboratory  
 MIT, Lincoln Laboratory  
 Naval Research Laboratory, Washington, D. C.  
 National Park Service  
 Royal Norwegian Council for Scientific and Industrial  
     Research  
 Texas Instruments  
 Teledyne Geotech, Garland, Texas  
 U. S. Dept. of Commerce, National Oceanic and  
     Atmospheric Administration  
 U. S. Dept. of Interior, Geological Survey  
  
 California Institute of Technology  
 Georgia Institute of Technology  
 Institute of Geophysics, Victoria University  
 MIT, Lincoln Laboratory  
 New Mexico Institute of Mining and Technology  
 Oregon State University  
 Pennsylvania State University  
 St. Louis University  
 Southern Methodist University  
 University of Alaska  
 University of California, Berkeley  
 University of California, San Diego  
 University of Edinburgh  
 University of Hawaii  
 Universitie Louis Pasteur  
 University of Minnesota  
 University of Oklahoma  
 University of Texas at Dallas  
 University of Utrecht  
 University of Washington at Seattle  
 University of Wisconsin

#### F. Analog Field Tape Supply

As a result of compression 683 tapes are  
 available to be shipped for field use. No compression  
 was done in June.

G. Array Data Service

During June, requests for 98 samples of NORSAR short period data were made, 56 were received from Norway. As of the end of May the SAAC/LASA weekly summary was being mailed to 30 recipients.